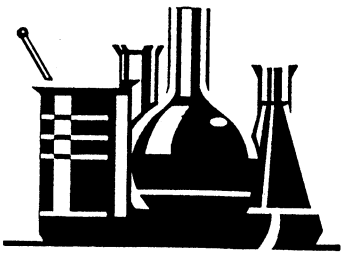


# SCHOOL LABORATORY SAFETY

## FOR TEACHERS AND LABORATORY SUPERVISORS

### General Information

The Division of Occupational Safety recommends that public schools in Massachusetts follow the basic concepts of the OSHA laboratory standard, 29 CFR 1910.1450 as well as comply with the specific Massachusetts laws pertaining to the facility. The OSHA standard was developed to protect employees and students from being overexposed to hazardous laboratory chemicals. Among the key elements necessary to have a safe laboratory is the presence of sufficient ventilation. Additional major factors that aid in promoting a safe laboratory include, but are not limited to, proper storage of hazardous chemicals, proper container labeling, proper equipment (both lab equipment and personal protective equipment), and an effective, well maintained program for safe laboratory practices and procedures.

### What are the Hazards

Improper chemical storage in laboratories is a significant source of accidents in the academic setting. There is a common misconception that inherent risks associated with the use of hazardous chemicals are higher in an industrial setting versus an academic one. The risk is actually greater in schools due to budget constraints, which inadvertently encourage practices such as over-ordering and over-stocking. Budget constraints often result in zero funding for proper disposal of unused or unwanted materials. Schools tend to be less diligent about complying with local, state and federal laws governing the use and disposal of hazardous materials, and there is a prevailing perception that they are exempt from such regulations. Schools should be held to the same standards as industry regarding responsible purchasing, safe use, secure and proper storage, and proper disposal of hazardous chemicals.

Improper use of fume hoods amplify the potential hazards of chemical reactions. Inadequate or inappropriate ventilation can contribute to toxic contaminants both in the science area and throughout the building. Proper grounding of conductive elements is frequently overlooked. Eyewashes may be completely absent, or may not be properly maintained. Functioning eyewashes and deluge emergency showers are required in all public schools, but often are not present in the lab, or are blocked by storage and could not be accessed in an emergency.

### Ventilation

Good laboratory exhaust ventilation contains or captures toxic contaminants at the source and transports them out of the building by means of ductwork and a fan. Laboratory safety requires a careful balance between exhaust and supply volumes, as well as location, design and quantity of exhaust and supply air. Laboratory air should be continually replaced with fresh air to prevent the buildup of toxic substances during the days—4 to 12 room air changes per hour should be adequate. Fresh makeup air should be returned to the room at a rate of 15 cubic feet per minute (CFM) per person for classrooms and 20 CFM for laboratories. Air changes per hour can be calculated in the following manner:

Mass Division of Occupational Safety
Occupational Hygiene/Indoor Air Quality Program
1001 Watertown St.
West Newton, Ma 02465 (617-969-7177)

1) measure the air flow at the exhausts or at the air supplies to the space

2) measure the room size to determine cubic feet (LxWxH=total cubic feet)

3) calculate the air changes as follows:air changes/hour=$\frac{\text{Total Exhaust (ft/min) or Supply x 60 min/hr}}{\text{Cubic feet of room (ft}^3\text{)}}$

Air flow measurements can be taken by our office on request or by your ventilation company.

**Pressurization**

Laboratories, laboratory classrooms, chemical storage areas and chemical prep areas should be maintained under slight **negative pressure** at all times. Negative pressure is maintained by exhausting more air from a room than is added back. By maintaining this negative balance, potential contaminants are less likely to migrate from the lab areas to other spaces throughout the school. The continual operation of exhaust fans or intermittent use of fume hoods can create negative pressure.

Room pressurization can be determined in one of two ways:

1) Quantitative: Measure the amount of exhaust and supply of the room, in CFM (feet/min x opening size $ft^2$). Exhaust should be at least 10% more than the supply or at least 50 CFM more.

2) Qualitative: Position one door of the room slightly ajar. Use a commercially purchased ventilation smoke tube to determine the direction of the air flow pathway. Indicator smoke being pulled into the room indicates negative pressurization. Indicator smoke traveling from the room and blowing back to the point of application indicates a positive pressurization.

**Fume Hoods**

Fume hoods offer significant protection in the laboratory. Their function is to capture, dilute and exhaust hazardous and/or noxious fumes. In addition to preventing toxic vapors from entering the general laboratory atmosphere, conducting experiments in a fume hood places a physical barrier between the individual and the potential hazards of the chemical reaction. Ideally, the hood should be equipped with a vapor proof light approved for hazardous atmospheres, externally mounted switch, adjustable sash, motor blower and electrical outlet. The work surface and any accessories (sinks, gas outlets) should be resistant to corrosion, chemicals and acid fumes. **Fume hoods are not intended for chemical or equipment storage, which ultimately reduces the effectiveness of the hood by 20-30%.** Inspection and qualitative testing of fume hoods should be done semi-annually, evaluating face velocity, air flow, exhaust, etc.

Evaluation of the operating efficiency of a fume hood is done by measuring the air flow in feet per minute (fpm) at the face of the hood. Minimum velocity should be 80-100 fpm, with an absolute maximum of 120 fpm with the sash half open. Fume hood testing can be conducted by our office on request or by your ventilation company.

## Hazardous Materials Storage

A complete inventory of the chemical storage area is fundamental to laboratory operations. Update this list monthly. Labs with no inventory system tend to be more disorganized and unkempt. Lack of a chemical inventory can lead to uncontrolled risks. One individual should be responsible for ordering materials for the entire department.

Additional considerations for the safe handling and storage of school laboratory chemicals include: (1) store minimum quantities to reduce risk of storage problems and (2) separate and isolate the most serious hazards. **Micro-systems** are advantageous for reducing the bulk of large containers, and packaging quantities most commonly used. Some chemicals have a relatively short shelf life, and others become more dangerous with age. Segregate chemicals which may react—acid stored in the presence of any cyanide salt would produce lethal hydrogen cyanide if they were inadvertently mixed.

Never store chemicals in a standard refrigerator, in a fume hood or in the classroom or laboratory proper. No unlabeled products should be stored ***anywhere*** in the science facility. Hazardous chemicals should be stored in locked safety cabinets within a central chemical storage area. All hazardous materials must be stored in cabinets specific to the type of chemical or material. Four types of chemicals should be identified: flammable, toxic, corrosive and reactive.

Corrosives and flammables should never be stored together. Acids and bases tend to be strong oxidizers capable of reacting violently with flammables. Separate storage must be provided for acids and bases. Chemicals exhibiting multiple hazards need to be segregated within the storage area. Concentrated sodium hydroxide and nitric acid are both strong corrosives, yet neither should be stored together in a single area due to their ability to react violently if mixed. Corrosives should not be stored in metal cabinets or particleboard (wood) cabinets. Do not store organic acids with mineral acids. To prevent off-gassing of acid fumes, all acids should be placed into a polyethylene bag and then placed into a sealed secondary container within a corrosives cabinet. Nitric acid is such a strong oxidizer that it needs to be stored in a separate compartment within the corrosives cabinet, and remain isolated from all other acids, particularly acetic acid. Combining nitric and acetic acid will result in an explosive reaction.

Store all chemicals in chemical families, organic and inorganic. Do not store or shelve chemicals alphabetically. Alphabetical storage results in incompatible chemical storage which can result in the formation of toxic vapors, fire and explosions. Compatibility can be found on the MSDS for the chemical, and in purchasing catalogs, which can also serve as excellent reference materials.

Many chemicals used in science laboratories are considered flammable liquids. Common flammable solvents include: ethyl alcohol, methyl alcohol, acetone and isopropyl alcohol. NFPA 30-Flammable & Combustible Liquid Code has regulations specifying when flammable liquids must be stored in approved flammable storage cabinets. In some cases it makes good sense to store flammables in an approved cabinet regardless of quantity. Venting of flammable storage cabinets is always an area of concern. Generally, NFPA does not recommend venting flammable storage cabinets on the basis that venting, in some cases, negates the storage protection and would aid in supplying oxygen to the

contents in the event of an incident. State law and the Uniform Fire Code also specify when approved cabinets must be used. Both flammable and combustible liquids can be classified into 3 classes each, based on their flash points.

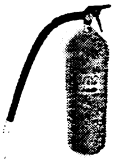
Although there are varying classes of flammable and combustible materials, flammables have a flash point below 100°F, and combustibles have a flash point at or above 100°F. Flammable and combustible classification can usually be found on the MSDS for the material in question.

**Labeling/Material Safety Data Sheets (MSDS)**

A consistent labeling system makes proper storage and maintenance of the chemical inventory much easier. The minimum information to list on a container is (1) chemical name spelled out, not the chemical formula; (2) concentration, molarity or strength; (3) hazards of the chemical, what target organs will be affected (detailed information can be obtained from the MSDS); (4) date prepared or date received if material was purchased from a supplier.

In order to ensure complete proper labeling of all chemicals in a storage room or laboratory, it is necessary to have copies of Material Safety Data Sheets (MSDSs) for all chemicals used or stored within the facility MSDSs can be obtained from the chemical manufacturer and/or supplier. School personnel also need to comply with the requirements of the Massachusetts Right to Know Law (RTK).

**Standard Safety Equipment**



*Fire Extinguishers*

All laboratories should be equipped with fire extinguishers. Combination type ABC extinguishers are recommended as well as several carbon dioxide extinguishers. A written statement regarding the facility's policy on use or non use of extinguishers by employees needs to be available. Spill control kits with dry, clean sand can also be used to extinguish small fires.

*Eyewashes/Emergency Showers*

Emergency wash systems and deluge showers which are hard piped and plumbed to a water supply are required in school laboratories by state law. The 1998 ANSI standard for emergency showers requires the shower to be located within 10 seconds travel distance from the hazard, on the same level as the hazard, and with the path of travel free of obstructions. The eyewash must deliver a minimum of 0.4 gallons per minute continuously for a 15-minute period. Stand-alone self-contained unit, or hand held bottles are not substitutes for deluge showers, but can be used to minimize damage while accessing a plumbed eyewash. Safety showers installed in corridors or walkways generally guarantee unobstructed access.

*Eye Protection, Minimum Personal Protective Equipment (PPE)*

Safety equipment should be chosen based on the material used and potential exposure. MSDSs provide guidance for the proper selection of safety equipment from ventilation to personal protective equipment (PPE). **Indirectly vented splash goggles for use with liquids, and safety glasses for general experimentation are also required by Massachusetts state law.** Many schools use goggles which are directly vented with holes on the top or sides. These goggles do not provide protection against splashes and are generally used in the wood shop area of the school. Goggles used in the wood shop classes cannot be interchangeably used in the chemistry laboratory. Face shields, gloves and chemical resistant aprons should also be available. There is no universal "chemical resistant glove" for protection against all chemicals. Glove manufacturers or suppliers are often a good source for helping you choose the right glove for the application. Manufacturers often have chemical resistance charts available for their products which offer a great deal of information regarding the selection of the proper gloves.

## Microscale Chemistry

The concept of microscale chemistry was developed to reduce hazardous wastes produced in the United States. It is a Total Quality Management (TMQ) approach to handling chemical wastes. Microscale uses minimum amounts of chemicals to achieve maximum results, reduces hazardous waste, minimizes chemical exposure to students and staff, and increases overall chemical safety.

Revised laboratory methods, glassware and means of chemical analyses are required to conduct chemical operations on this scale. Microscale chemistry limits solids to 25-100mg and liquids to 100-2000µl. Reducing solvent volume use results in improved air quality, reduced exposure to potentially toxic chemicals, and virtually eliminates chances of fire and explosion. All academic facilities should consider implementing a microscale chemistry program. Additional information may be acquired by contacting the National Microscale Chemistry Center at Merrimack College in North Andover, MA 508-837-5137 or *www.silvertech.com/microscale*.

## Regulatory Compliance/Right to Know

In accordance with Massachusetts General Law Chapter 149 section 6, DOS is responsible for ensuring that the health and safety of teachers and other school employees is protected. To provide maximum protection to public sector employees, DOS references OSHA standards, safe work practices, industry standards and Massachusetts general laws. Schools often perceive, incorrectly, they are exempt from regulations. In addition to MGL Chapter 149 section 6, all schools must comply with the Massachusetts Right to Know law requirements. Right to Know requires posting a workplace notice a chemical inventory, proper labeling, Material Safety Data Sheets and employee training. Schools also need to comply with state hazardous waste laws, board of fire prevention regulations, and Dept. of Transportation (DOT) regulations. Recycling, material substitution, toxic use reduction and waste minimization are additional concepts that promote the general safety of school laboratories. It is the responsibility of the school administration to ensure that they are current and in compliance with all laws and regulations applicable to their facilities.

**Where to get Information**

- You may request an on site consultation by one of our staff. This consultation will be provided free of charge and will include a review of your current chemical storage and general laboratory safety. The consultant will provide you with a written report and recommend procedures you will need to implement. There are no fees for this service, nor are there fines or penalties associated with the initial discovery of non-compliance. However, you will be required to comply with some of the more critical recommendations made. Information can be obtained at the DOS website, www.state.ma.us/dos, and the OSHA website www.osha.gov for general reference, including the OSHA Laboratory Standard.

- Other source references are available upon request.

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If you would like more information or assistance please fill out and copy this form and send to the address below.

I would like to request an on site consultation at my facility ☐

I would be interested in attending a free training seminar if made available ☐

Name:_____Title:_____

Mailing
Address:_____City/Town:_____Zip:_____

Telephone Number: (  )_____

**Mass Division of Occupational Safety**
**Occupational Hygiene/Indoor Air Quality Program**
**1000 Watertown Street**
**West Newton, MA 02465**
**(617) 969-7177**

NOTE: This bulletin is provided for informational purposes only and is not meant to be a comprehensive compliance document.